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AN EFFICIENT TECHNIQUE BASED ON NUMERICAL MODE MATCHING FOR THE ACOUSTIC CHARACTERIZATION OF DISSIPATIVE SILENCERS WITH THERMAL GRADIENTS

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In this work, a computationally efficient numerical technique based on the mode matching method is presented to model and analyse the acoustic behaviour of dissipative silencers. Three-dimensional wave propagation and temperature gradients are considered in the absorbent material while a perforated duct separates the dissipative region and the central passage. The use of a full multidimensional finite element formulation is computationally expensive in configurations with arbitrary geometry and complex thermal gradients [1]. To avoid this drawback, a technique is proposed combining axial and transversal solutions of the wave equation in the different ducts. The latter are obtained through a two-dimensional finite element approach that allows the computation of the eigenvalues and eigenvectors associated with the transversal section [2], including radial temperature gradients and the corresponding thermal-induced heterogeneities of the absorbent material properties [3]. Due to the reduced acoustic impact of axial gradients compared to radial variations [1], an axially uniform temperature field is assumed, its value being the inlet/outlet average. Then, the compatibility equations of the acoustic field (pressure and axial acoustic velocity) at the geometric discontinuities together with the mode matching method [2] are used to obtain the wave propagation coefficients in the different regions of the silencer, such as the central chamber and the inlet/outlet pipes. This methodology is compared with the results given by full three-dimensional finite element computations including axial and radial temperature gradients, showing a good agreement with lower computational requirements.

REFERENCES

[1] F. D. Denia, E. M. Sánchez-Orgaz, J. Martínez-Casas, R. Kirby. Transmission loss predictions for dissipative silencers with high temperature and thermal-induced heterogeneity. Submitted to Journal of Sound and Vibration (2013).
[2] R. Kirby. A comparison between analytic and numerical methods for modelling automotive dissipative silencers with mean flow. Journal of Sound and Vibration, **325**, 565-582 (2009).
[3] A. G. Antebas, F. D. Denia, A. M. Pedrosa, F. J. Fuenmayor. A finite element approach for the acoustic modeling of perforated dissipative mufflers with non-homogeneous properties. Mathematical and Computer Modelling, **57**, 1970-1978 (2013).